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

Sample Assessment Tasks

Aviation
ATAR Year 11

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Sample assessment task

Aviation – ATAR Year 11

Task 7 – Unit 2

Assessment type: Investigation

Conditions
Time for the task: 2 weeks

Task weighting
5% of the school mark for this pair of units

Development of four-stroke internal combustion engines

Trace the development of the four-stroke internal combustion engine between 1860 and 1920 and discuss how it was adapted to meet the requirements for powered flight.

Include the following in your answer:

- construct a timeline to outline five Major developments (dates, person/company and description) for each time period of the four-stroke, internal combustion engine:
  - 1860 to 1903
  - 1903 to 1920 (four-stroke engines used in aircraft)
- describe the major components of a four-stroke internal combustion engine (include a hand-drawn, well-labelled diagram)
- explain the principles of operation of a four-stroke internal combustion engine
- compare the following types of engines used in aircraft from 1903 to1920 (design, advantages/impact and limitations)
  - horizontally opposed
  - in-line
  - rotary
  - radial
- cite references in your bibliography in the correct format (use at least **three (3)** references).

Your research should be written in report style and submitted as a word document. Use headings and sub-headings (if applicable) when addressing the criteria. Include diagrams to illustrate your answer where possible.

Marking key for sample assessment task 7 – Unit 2

Trace the development of the four-stroke internal combustion engine between 1860 and 1920 and discuss how it was adapted to meet the requirements for powered flight.
Include the following in your answer:

- construct a timeline to outline five Major developments (dates, person/company and description) for each time period of the four-stroke, internal combustion engine:
  - 1860 to 1903
  - 1903 to 1920 (four-stroke engines used in aircraft)

Development of the internal combustion engine (1860–1903)

Description	Marks
Any five of the following (1 mark for date, 1 mark for person/company/1–2 marks for a description of the development: • first internal combustion engine • first atmospheric engine • first compression engine • Atkinson cycle engine • first petrol engine • rotary engine/s • diesel engine • boxer/horizontally opposed/flat engine	1–20
Answer could include, but is not limited to:	

Teacher notes:

Date	Person/company	Major development	Notes
1860	Jean Joseph Etienne Lenoir	First internal combustion engine (2-stroke)	The engine was 4% efficient, producing 2 hp
1861	Alphonse Beau de Rochas	Earliest confirmed patent of the 4-cycle engine	
1862	Nikolaus August Otto	First successful atmospheric engine with 12% efficiency	
1867	Nikolaus August Otto & Eugen Langen	Free piston engine	Paris Exhibition
1876	Nikolaus August Otto and Eugen Langen [Gottlieb Daimler and Wilhelm Maybach] Deutz Gasmotorenfabrik AG	First internal combustion engines that compressed the fuel mixture prior to combustion with 30% efficiency	Patent did not cover all in-cylinder compression engines/4-stroke cycle. In-cylider compression then became universal
1882	James Atkinson	Atkinson cycle engine	One power phase per revolution
1884	Edward Butler	First petrol (gasoline) internal combustion engine	
1885	Gottlieb Daimler and Wilhelm Maybach	First automobile (Daimler Reitwagen)	High speed Otto engine developed in 1883
1886	Karl Benz	First cars in production	4-stroke engine automobile
1889	Felix Millet	First vehicle powered by a rotary engine	Engine patented 1888. 5 cyl rotary engine built into a bicycle wheel (motorcycle)
1890s	Stephen Balzer	Constructed rotary engines	Bankrupt. Took part in Langley's Aerodrome attempts

Date	Person/company	Major development	Notes
1893	Rudolph Diesel	Diesel engine	
1896	Karl Benz	Boxer engine (horizontally opposed engine or flat engine)	The corresponding pistons reach top dead centre at the same time, balancing each other in momentum
1898	Adams-Farwell/ Fay Oliver Farwell	3 cyl rotary engines	Used in Adams-Farwell's cars. Precursor to Gnome engines

Development of the aircraft engine (1903–1920)

Description	Marks
Any five of the following (1 mark for date, 1 mark for person/company/1–2 marks for a description of the development: • in-line engine (Wright Flyer) • water-cooled radial engine • air-cooled radial engine • V8 water-cooled engine • rotary engine (Gnome) • turbocharger • horizontal opposed	1–20
Answer could include, but is not limited to:	

Teacher notes:

Date	Person/company	Major development	Notes
1903	Charlie Taylor (Wright brothers)	**In-line aeroengine** (4 cyl) for the Wright flyer (12 hp)	First powered flight by Wilbur and Orville Wright in Kitty Hawk North Carolina
1903	C.M. Manley	Water-cooled **Manley-Balzer radia**l engine (5 cyl)	Converted Balzer's rotary engine to a static radial engine. Set standards for later radial engines
1903–1904	Jacob Ellehammer	First air-cooled radial engine	Short flights in triplane
1905–1906	Leon Levavasseur	V8 water-cooled engine	
1908	Louis Seguin/Gnome	Gnome Omega – First **rotary** engine produced in quantities	Gnome powered Farman III aircraft set world endurance record (180 km) in 1909
1909	Georges Canton & Pierre Unne	Canton-Unne **water-cooled radial engine**	Successfully used in WWI
1911	Alessandro Anzani	Anzani (6 cyl) – First two row **radial** engine	Built early radial engines. Used in Louis Bleriot's XI across the English Channel in 1909
1912	Gnome	Gnome twin row radial design	Gnome Double Lambda German Oberursel U.III clone
1914	Auguste Rateau	**Turbocharger** designed and tested but not accepted	Exhaust powered compressor to improve high altitude performance
1916		First US **horizontally opposed air-cooled** engine	

Date	Person/company	Major development	Notes
1916		Le Rhone 9C9 (9cyl) **Rotary** engine	French rotary radial. Air cooled engine used in WW1 fighters
1917–1918	Brown-Boveri	Earliest known **supercharger**-equipped aircraft to fly (Brown-Boveri on Mercedes engines)	WWI German Zeppelin-Staaken R.V1 heavy bomber
1918	Dayton-Wright Airplane Co.	Liberty **V12** mass produced for WWI by US	Used in De Havilland DH-4s in WWI by US. Over 20 000 were made
1918	Sanford Alexander Moss	First successful **turbocharger**	Based on Rateau's idea

- describe the major components of a four-stroke internal combustion engine (include a hand-drawn, well-labelled diagram)

Description	Marks
Accurately draws a fully labelled diagram including ten of the following components: • crankshaft • crankcase • piston/piston rod/connecting rod • cylinder • combustion chamber • intake manifold/intake valve/inlet valve • exhaust valve • rocker arm • electrical contact/spark plug • water jacket	1–10
Total	**/10**

- explain the principles of operation of a four-stroke internal combustion engine

Description	Marks
1. Intake stroke	**1–3**
• provides a detailed explanation of the intake stroke including labelled diagrams	3
• provides a brief explanation of the intake stroke or draws a labelled diagram of the intake stroke	2
• names the intake stroke and states its purpose	1
2. Compression stroke	**1–3**
• provides a detailed explanation of the compression stroke including labelled diagrams	3
• provides a brief explanation of the compression stroke or draws a labelled diagram of the intake stroke	2
• names the compression stroke and states its purpose	1
3. Power stroke	**1–3**
• provides a detailed explanation of the power stroke including labelled diagrams	3
• provides a brief explanation of the power stroke or draws a labelled diagram of the intake stroke	2
• names the power stroke and states its purpose	1

4. Exhaust stroke	1–3
• provides a detailed explanation of the exhaust stroke including labelled diagrams	3
• provides a brief explanation of the exhaust stroke or draws a labelled diagram of the intake stroke	2
• names the exhaust stroke and states its purpose	1
Total	**/12**

- compare the following types of engines (horizontally opposed, in-line, rotary, radial) used in aircraft from 1903 to 1920 (design, advantages/impact and limitations)

Description					Marks
Any one of the following points in each box for one mark.					
	Type of engine				
	Inline	Horizontally opposed/boxer	Radial	Rotary	
Design	• Cylinders lined up in a row	• Two banks of cylinders on opposite sides of a centrally located crankcase	• One or more rows of cylinders arranged around a centrally located crankcase. Odd number in each row	• Cylinders are in a circle around the crankcase, but the crankshaft is fixed to the airframe and propeller fixed to engine case. The crankcase and cylinders rotate	4
Advantages/ Impact	• Wright flyer – first heavier than air, self propelled, manoeuvrable, piloted aircraft • Inspired further development of aircraft	• Much shorter crankshaft/crankcase reduces the power to weight ratio • Popular engines used on small aeroplanes	• Air-cooled engine reduces the weight • Reliability – shorter crankshaft produces less vibration. Reduces wear and fatigue • Radial engines generally run smoother	• Had speed and agility • Used to power bombers during WWI, but not continued after the war	4
Limitations	• Long crankshaft and crankcase, with water cooling makes it very heavy	• Shape not streamlined and impedes visibility for pilots	• Having all of the cylinders exposed to the airflow increases drag • Pilot visibility is often poorer due to the bulk of the engine • Lower cylinders collect oil when stopped and if not cleared causes serious damage to hydrostatic lock	• Gyroscopic effect of the heavy rotating engine produces handling problems • A large amount of oil is consumed as it is mixed with the fuel and ejected into exhaust fumes • Castor oil used during the war produced fumes	4
				Total	**/12**

- cite references in your bibliography in the correct format (use at least **three (3)** references).

Description	Marks
• cites three references	1–3
• uses correct formatting for references	1–2
Total	**/5**

ACKNOWLEDGEMENTS

Development of the aircraft engine (1903 to1920): teacher notes

Information from: *History of the internal combustion engine*. (2014). Retrieved June, 2014, from http://en.wikipedia.org/wiki/History_of_the_internal_combustion_engine
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Development of the aircraft engine (1903 to1920): teacher notes

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Sample assessment task

Aviation – ATAR Year 11

Task 10 – Unit 2

Assessment type: Test – Human factors

Conditions
Period allowed for completion of the task: 1 hour

Task weighting
4% of the school mark for this pair of units

Multiple-choice **(10 marks)**

1. The structure that controls the amount of light entering the eye is the

   (a) pupil.
   (b) lens.
   (c) iris.
   (d) ciliary muscle.

2. The two parts of the eye that affect the focus of light rays onto the retina are the

   (a) lens and fovea.
   (b) lens and cornea.
   (c) fovea and iris.
   (d) cornea and iris.

3. In order to maintain focus on an object as it approaches more closely, the eye will

   (a) contract the ciliary muscle causing the lens to bulge.
   (b) relax the ciliary muscle causing the lens to bulge.
   (c) tighten the suspensory ligaments on the lens and thereby flatten the lens.
   (d) dilate the pupil so that more light can be used to accommodate the object.

4. 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.

5. At night, by looking to the side of (rather than straight at) dimly lit ground objects, pilots will usually

(a) be less susceptible to spatial disorientation.
(b) not lose their dark adaptation.
(c) distinguish colours more easily.
(d) see the objects more clearly.

6. Jill has hypermetropia. If she goes flying without corrective spectacles, she will have diffculty in

(a) seeing near objects.
(b) seeing distant objects.
(c) distinguishing colours at night.
(d) seeing both near and distant objects.

7. A pilot with a high count of red blood cells will perform well in tests of physical endurance because

(a) waste products will be removed from the body easily.
(b) excess levels of glucose will increase levels of respiration.
(c) the reduced plasma volume will lower carbon dioxide levels.
(d) high levels of oxygen will be available to the muscles.

8. The right ventricle of the heart pumps:

(a) oxygenated blood to the rest of the body
(b) deoxygenated blood to the right atrium
(c) deoxygenated blood to the lungs
(d) oxygenated blood to the right atrium

9. The eardrum is otherwise known as the

(a) pinna.
(b) tympanic membrane.
(c) auditory canal.
(d) oval window.

10. Blood does not usually come into contact with the cells it supplies. Exchange of gases between the blood and the cells occurs through

(a) capillary networks.
(b) lymphatic vessels.
(c) extracellular fluid.
(d) intracellular fluid.

Short answer **(37 marks)**

11. (a) 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. (12 marks)

    (b) A passenger suffering from a head cold experiences pain inside the ear during the descent. Explain, with reference to the structures of the ear and outline the risks of damage that may occur. (5 marks)

12. (a) Use a diagram to explain the process of inhaling a breath of air by humans. (11 marks)

    (b) A pilot ejects from an aircraft at very high altitude. Even though his mask is still delivering oxygen, he may find he cannot inhale successfully. Explain the reason. (2 marks)

13. (a) Describe how the circulatory system transports oxygen around the body. (4 marks)

    (b) Typical cruising altitudes in commercial aircraft are in the range of 11 000–12 200 metres (36 000–40 000 feet) and aircraft cabins have to be pressurised. Explain how travel in pressurised aircraft can affect the levels of oxygen in the blood. (3 marks)

Marking key for sample assessment task 10 – Unit 2

Multiple-choice **(10 marks)**

Question	Correct response
1	c
2	b
3	a
4	b
5	d
6	a
7	d
8	c
9	b
10	c

Short answer **(37 marks)**

11. (a) 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. (12 marks)

Description	Marks
Vestibule (utricle and saccule) • labelled diagram of the macula (gelatinous mass) to show otoliths, sensory hair cells and nerve fibres/vestibular nerve	1–4
• hair cells (utricle) are embedded in a gelatinous mass coated on top by dense calcium carbonate/otoliths • acceleration/deceleration/changes in linear motion cause the otoliths to move and trigger the hair cells which generate nerve impulses to the brain	1–2
Semicircular canals • labelled diagram of the ampulla (swollen base of each semicircular canal) to show endolymph, cupula, sensory hair cells and nerve fibres/vestibular nerve	1–4
• set at right angles to each other/detects direction of movement • changes in direction bend the cupula and stimulate hair cells which generate a nerve impulse to the brain	1–2
Total	**/12**

(b) A passenger suffering from a head cold experiences pain inside the ear during the descent. Explain, with reference to the structures of the ear and outline the risks of damage that may occur. (5 marks)

Description	Marks
• middle ear is connected to the throat by the Eustachian tube • allows air pressure in the middle ear to remain same as the outside air • eustachian tube becomes blocked with a cold • pressure is not equalised/change in external air pressure during descent causes pain	1–4
• risk–burst tympanic membrane/eardrum	1
Total	**/5**

12. (a) Use a diagram to explain the process of inhaling a breath of air by humans. (11 marks)

Description	Marks
Labelled diagram showing the trachea, bronchus/bronchi, lung, diaphragm	1–4
Inhalation • diaphragm contracts and flattens • intercostal muscles contract to pull the ribs upwards and outwards • increases the volume of the thoracic cavity • pressure gradient is created/low air pressure in the thoracic cavity • air moves from relatively high pressure outside to equalise the pressure/lungs inflate	1–5
Exhalation • intercostal muscles and diaphragm relax • reduces the volume of the thoracic cavity/increases the pressure/forcing air out of the lungs	1–2
Total	**/11**

(b) A pilot ejects from an aircraft at very high altitude. Even though his mask is still delivering oxygen, he may find he cannot inhale successfully. Explain the reason. (2 marks)

Description	Marks
• difference between the pressure inside the thoracic cavity and the atmosphere is less at high altitudes • the mechanical process depends on this difference in pressure making it difficult to inhale	1–2
Total	**/2**

13. (a) Describe how the circulatory system transports oxygen around the body. (4 marks)

Description	Marks
• red blood cells/erythrocytes • contain haemoglobin • haemoglobin combines with oxygen to form oxyhaemoglobin • in oxygen-deficient areas the oxyhaemoglobin releases the oxygen	1–4
Total	**/4**

(b) Typical cruising altitudes in commercial aircraft are in the range of 11 000–12 200 metres (36 000–40 000 feet) and aircraft cabins have to be pressurised. Explain how travel in pressurised aircraft can affect the levels of oxygen in the blood. (3 marks)

Description	Marks
• cabin air pressure is lower than air pressure at sea level/air pressure decreases as altitude increases	1
• less oxygen is taken up by the blood	1
• this can result in hypoxia	1
Total	**/3**