Aerospace Systems 2019 v1.1

Unit 1 sample assessment instrument

July 2018

Examination

This sample has been compiled by the QCAA to assist and support teachers in planning and developing assessment instruments for individual school settings.

Schools develop internal assessments for each senior subject, based on the learning described in Units 1 and 2 of the subject syllabus. Each unit objective must be assessed at least once.

Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

1. recognise and describe problems, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to aerospace systems and structures
2. symbolise and explain ideas, solutions and relationships in relation to aerospace systems and structures
3. analyse problems and information in relation to aerospace systems and structures
5. synthesise information and ideas to propose possible aerospace systems and structures solutions
7. evaluate and refine ideas and solutions to make justified recommendations

Note: Objectives 4, 6 and 8 are not assessed in this instrument.

Subject	Aerospace Systems
Technique	Examination
Unit	Unit 1: Introduction to aerospace systems and structures
Topic	1, 2, 3, 4, 5

Conditions			
Response type	Short response		
Time	2 hours	**Perusal**	10 minutes
Other	• seen stimulus — teachers must ensure the purpose of the technique is not compromised • unseen stimulus — materials or questions must not be copied from information or texts that students have previously been exposed to or have used directly in class • when stimulus materials are used, they will be succinct enough to allow students sufficient time to engage with them; for stimulus materials that are lengthy, complex or large in number, they will be shared with students prior to the administration of the assessment instrument • only the QCAA formula sheet must be provided • notes are not permitted • use of technology is required: non-programmable scientific calculator only permitted • protractor and ruler required		

Instructions
• Answer all questions in **Section 1** and **Section 2** on the paper in the space provided for each item. • For multiple-choice questions, circle the letter next to your chosen answer. If you want to change your answer, cross out your initial choice and circle the letter next to your new answer. • Word length for short-response items is 50–150 words per item. • Some responses may require calculations, sketching, drawing, graphs, tables or diagrams. • **Section 2:** show all working for questions requiring calculations.

Feedback

Section 1 — Multiple-choice items

Question 1

Sir Charles Kingsford-Smith, an early Australian aviation pioneer, was most renowned for being

(A) the founder of Qantas.

(B) responsible for establishing the Royal Mail Air Route.

(C) the first person to fly from the United Kingdom to Australia.

(D) the first person to fly non-stop from the United States to Australia.

Question 2

Which of the following needs had the **least** influence on the historical development of international airline transport systems?

(A) Safe international air transport

(B) Standardisation of procedures across countries

(C) Increased profitability of international air transport

(D) Fair and equitable rights to operate international airlines

Question 3

The manager of EverReady Airlines is concerned about the delays experienced by their airline at a busy regional airport. The manager arranges to meet with airport staff from airside and landside operations, air traffic control and the Bureau of Meteorology to understand the reasons behind the delays. By doing this, which systems thinking habit is the manager most clearly demonstrating?

(A) Mental models

(B) Consequences

(C) Considering issues fully

(D) Changes in perspectives

Question 4

The angle of attack of an aircraft's wing is the angle between the relative airflow and the

(A) wing chord line, which can be changed in flight.

(B) longitudinal axis, which can be changed in flight.

(C) wing chord line, which cannot be changed in flight.

(D) longitudinal axis, which cannot be changed in flight.

Question 5

An aircraft flying at Mach 1.3 at sea level in international standard atmosphere (ISA) conditions, would be travelling at approximately

(A) 667 knots.

(B) 867 knots.

(C) 1326 km/h.

(D) 1726 km/h.

Question 6

Figure 1 (below) represents the head-on view of an aircraft climbing after take-off. The pilot's actions during this flight manoeuvre would include

Figure 1

Vasters. C 2017. 'Embraer E195 E2'. CC BY 2.0. commons.wikimedia.org/wiki/File:Embraer_E195_E2_(34610191664).jpg

(A) pulling back on the control column and turning the control column left.

(B) pulling back on the control column and turning the control column right.

(C) pushing forward on the control column and turning the control column left.

(D) pushing forward on the control column and turning the control column right.

Question 7

A student pilot is on their first solo flight. They accidentally bump the control column and the aircraft noses up steeply, then down steeply. The student does nothing to stop this but, luckily, the aircraft's 'ups' and 'downs' decrease in severity and eventually disappear altogether, then the aircraft returns to level flight by itself. This demonstrates an example of

(A) positive static stability.

(B) negative static stability.

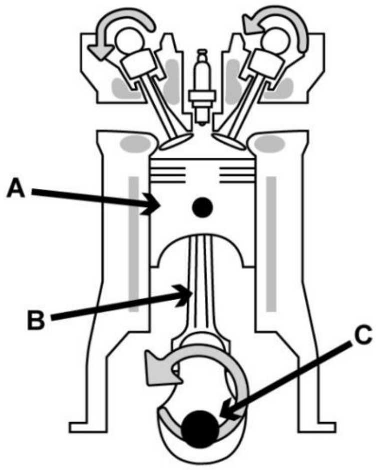
(C) positive dynamic stability.

(D) negative dynamic stability.

Question 8

The cut-away diagram of a four-stroke petrol engine cylinder (Figure 2) includes a number of labelled engine components. The engine components corresponding to A, B and C (in order) are the

Figure 2



(A) crankshaft, barrel and oil sump.

(B) piston, chamber and propeller shaft.

(C) piston, connecting rod and crankshaft.

(D) rod bearing, barrel and connecting rod.

Question 9

The primary purpose of a carburettor is to

(A) ignite the fuel.

(B) start the engine.

(C) provide the engine with an appropriate air-fuel mixture.

(D) prevent fuel contaminants getting into the engine and creating wear.

Question 10

Condensation nuclei involved in the formation of clouds are

(A) water vapour.

(B) superheated particles in clouds.

(C) tiny particles that assist in forming liquid droplets.

(D) particles that make the deposition process easier, i.e. ice crystal formation.

Section 2 — Short-response and calculation items

Question 1

Aviators encountered many problems during the early development of aircraft. They often engaged in flights and activities that would be considered extremely dangerous today. However, risks taken have helped to advance the role of aviation in the modern technological world. Choose one pioneer aviator you have studied and explain the aerospace era they lived in, their most notable achievements, the aircraft they flew and the problems they faced and overcame.

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Question 2

Compare and contrast the following two types of aircraft in terms of features and the materials used in their construction.

Figure 3

Max Pixel, 'Nieuport 17 French Biplane Fighter World War I', Creative Commons Zero – CC0
maxpixel.freegreatpicture.com/Nieuport-17-French-Biplane-Fighter-World-War-I-1162559

Figure 4

Pingstone, A 2007, 'Bombardier Learjet 60 business jet', Public Domain, Wikimedia Commons
commons.wikimedia.org/wiki/File:Bombardier.learjet 60.oe-gtf.arp.jpg

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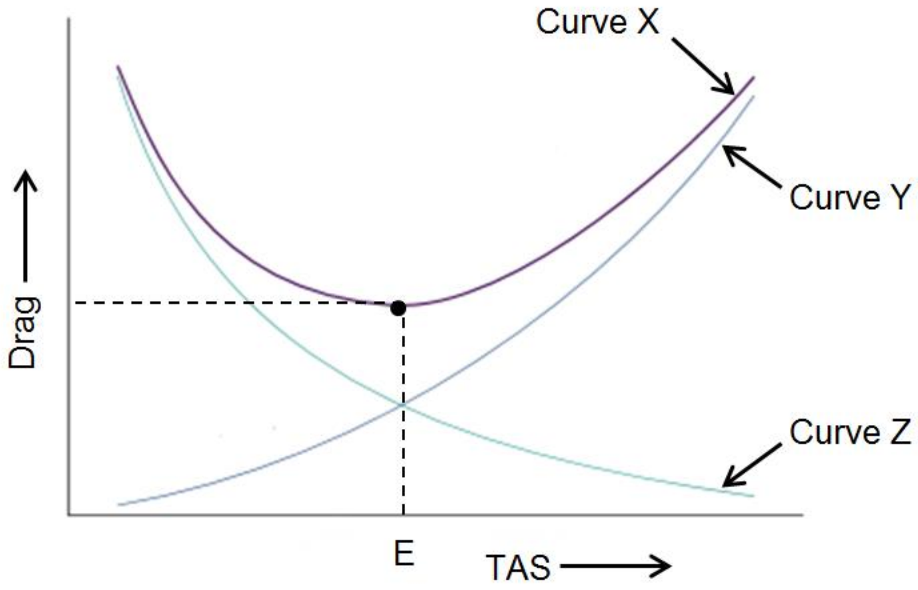
Question 3

The graph below shows three curves related to types of drag.

Figure 5



Cleynen, O 2016, 'Drag curves for aircraft in flight', Creative Commons CC0 1.0, Wikimedia Commons commons.wikimedia.org/wiki/File:Drag_curves_for_aircraft_in_flight.svg

a. Identify the drag types represented by curves X, Y and Z.

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b. Explain what is represented by the point marked E, and how commercial airlines use this information.

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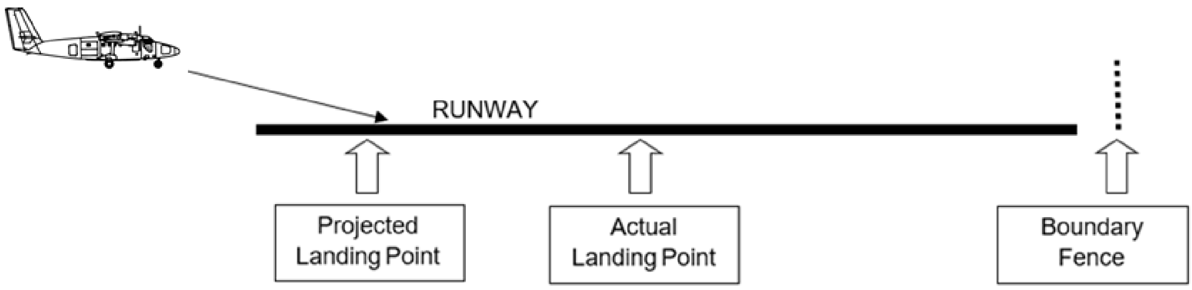
Question 4

The flight profile in Figure 6 shows the descent flight path of a light aircraft on approach to landing. Conditions on the day were fine, with no wind. On approach, the pilot maintained a suitable initial approach speed and used the appropriate aircraft flaps.

The projected landing point is the extension of the descent flight path. The aircraft landed beyond this point causing it to crash into the boundary fence at the end of the runway. The pilot made no significant changes to the controls and noted in the accident report that the aircraft 'just wouldn't land'.

Figure 6



FM 44-80 Visual Aircraft Recognition chapter 9 (US-Government), 'De_Havilland_Canada_UV-18A_Twin_Otter', Public Domain, Wikimedia Commons commons.wikimedia.org/wiki/File:De_Havilland_Canada_UV-18A_TWIN_OTTER.png

a. Provide a detailed explanation of what could have caused the aircraft to land beyond the projected landing point and crash into the boundary fence.

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b. How could the incorrect landing have been prevented?

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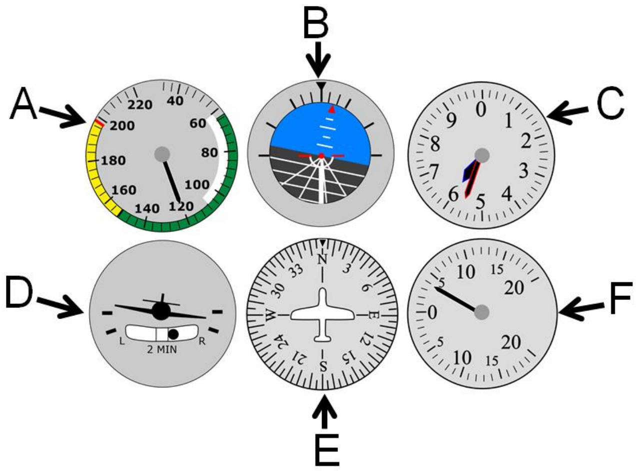
Question 5

Refer to the six flight instruments in Figure 7 to answer the questions below.

Figure 7



Luftpirat 2008, 'Basic flight instruments turn problem 2', Public Domain,
Wikimedia Commons commons.wikimedia.org/wiki/File:BasicFlight_instruments_turn_problem_2.svg

a. Name each flight instrument.

A ....

B ....

C ....

D ....

E ....

F ....

b. Analyse the readings on the six instruments to explain what the aircraft is doing.

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c. Select the two instruments which would have the least impact on the flight of an aircraft if they failed and justify your selection.

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Question 6

Compare and contrast the components, cycles, fuel types and thrust generation of internal combustion piston-driven engines and gas turbine engines. Include basic sketches to support your response.

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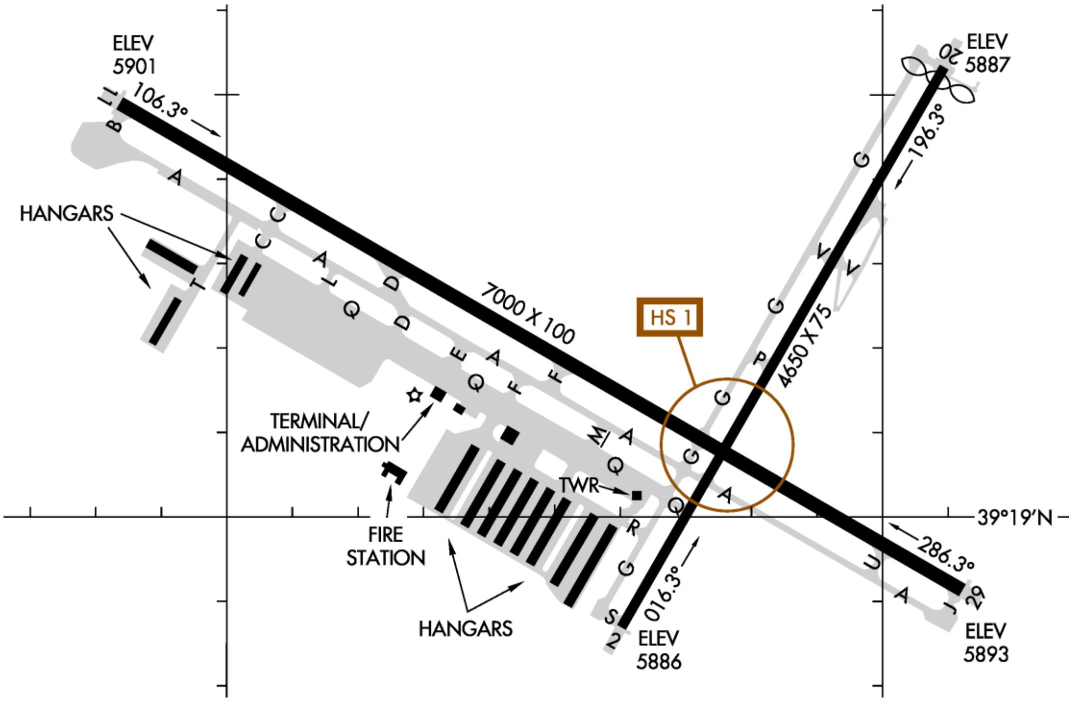
Question 7

A VFR pilot is currently airborne and due to arrive at BDWS at 0400 UTC. The following forecast has been provided to the pilot.

TAF BDWS 210400Z 12015G45KT 3000 BKN010CB SCT060 27/23 Q1009 FM 0430 21005KT 8000 SH OVC045 INTER 0430/0530 3000 SCT010 SCT025

The runway layout for BDWS is:

Elevation 26 feet



US Federal Aviation Administration 2016, 'Runway diagram for Trukee Tahoe Airport KTRK', Public Domain, Wikimedia Commons commons.wikimedia.org/wiki/File:Runway_Diagram_for_Trukee_Tahoe_Airport_KTRK.png

Figure 8

Explain what the pilot should do in this situation to land the aircraft safely. Justify your explanation.

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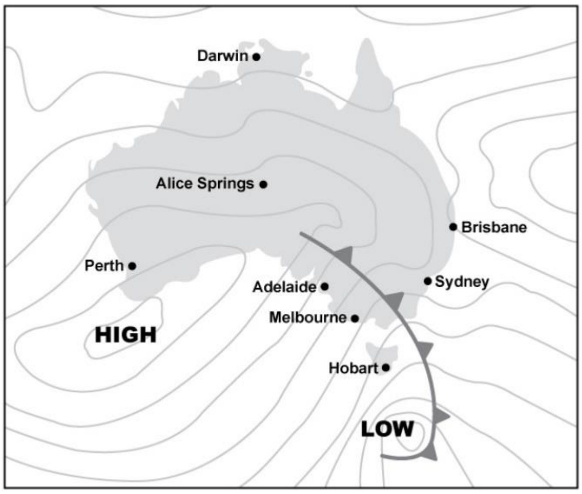
Question 8

Cold and warm fronts can present various problems to aircraft in flight. This synoptic chart (Figure 9) shows a large cold front over south-east Australia.

Figure 9



a. What weather conditions would be expected during a light aircraft flight from Sydney to Melbourne?

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b. What action should the pilot take based on the expected weather conditions? Justify your decision using information provided in the synoptic chart. Use sketches to support your reasoning.

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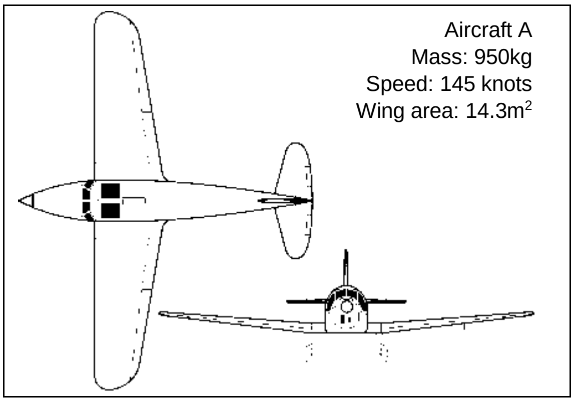
Question 9

Aircraft A and Aircraft B are tested in a wind tunnel with an air density of 0.8 kg/m^3. Each aircraft was developed to have a high coefficient of lift and a low wing loading. Which aircraft would you expect to be the most efficient and why?

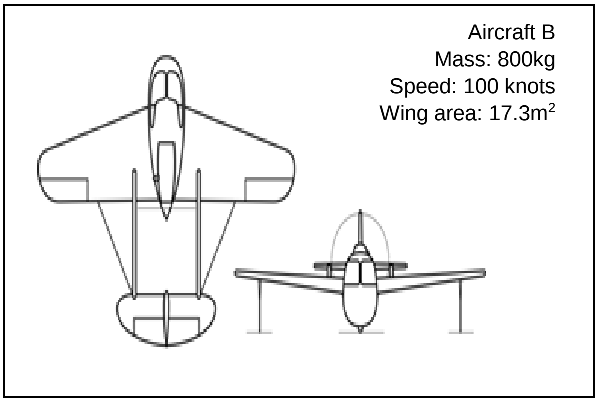
(**Note:** Lift equation: $\text{lift} = C_L \frac{1}{2} \rho V^2 A$ and 1 nautical mile = 1852 metres.)

Figure 10



MLWatts 2012, 'Arado Ar 79 3-view', Creative Commons CC0 1.0 Universal Public Domain Dedication, Wikimedia Commons
commons.wikimedia.org/wiki/File:Arado_Ar_79_3-view.svg

Figure 11

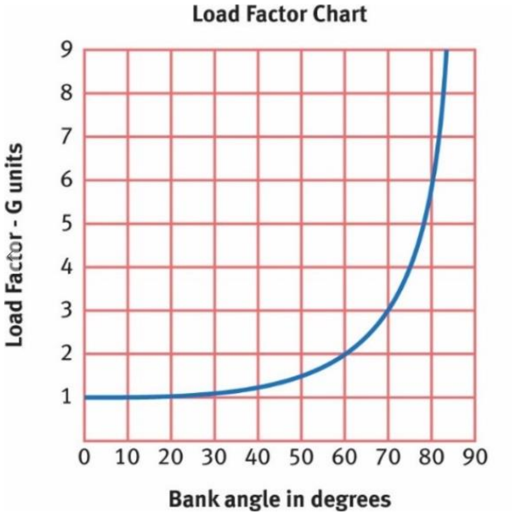


MLWatts 2012, 'Alaparma 65 Baldo 3-view', Creative Commons CC0 1.0 Universal Public Domain Dedication, Wikimedia Commons
commons.wikimedia.org/wiki/File:Alaparma_65_Baldo_3-view.svg

Question 10

Air crash investigators have been called to the site of an aircraft crash to determine possible reasons for the crash. When arriving at the scene, they make some discoveries:

- The flight manual is recovered and states that the aircraft had a Vs0 of 110 knots and a Vs1 of 120 knots.
- The aircraft is known to have a design limit of +5.5 g and –2 g.
- On inspecting the wreckage, it is noted that
  - AH and ASI were smashed
  - AH was reading an angle of bank of 80° and the ASI was indicating 150 knots
  - The flaps were fully up on impact.



Brooksby, S 2013, 'Load Factor Chart', used with permission
learntoflylv.com/aerodynamicspage2.htm

Figure 12

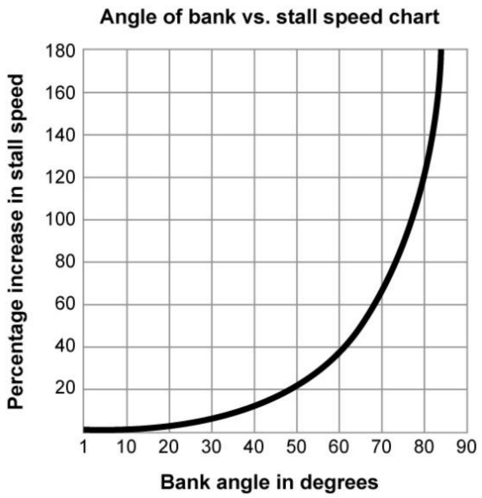


Figure 13

a. What conclusion can be drawn about the cause of the crash? Support your conclusion using relevant calculations and the graphs in Figure 12 and Figure 13.

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b. What advice should be provided to pilots to avoid this type of accident in the future?

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References

Figure 1: Vasters, C 2017, 'Embraer E195 E2', CC BY 2.0, Wikimedia Commons
commons.wikimedia.org/wiki/File:Embraer_E195_E2_(34610191664).jpg

Figure 3: Max Pixel, 'Nieuport 17 French Biplane Fighter World War I', Creative Commons Zero – CC0
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Figure 5: Cleynen, O 2016, 'Drag curves for aircraft in flight', Creative Commons CC0 1.0, Wikimedia Commons
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Figure 6: FM 44-80 Visual Aircraft Recognition chapter 9 (US-Government), 'De_Havilland_Canada_UV-18A_Twin_Otter', Public Domain, Wikimedia Commons
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Figure 7: Luftpirat 2008, 'Basic flight instruments turn problem 2', Public Domain, Wikimedia Commons
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Figure 8: US Federal Aviation Administration 2016, 'Runway diagram for Trukee Tahoe Airport KTRK', Public Domain, Wikimedia Commons
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