2003 HIGHER SCHOOL CERTIFICATE EXAMINATION

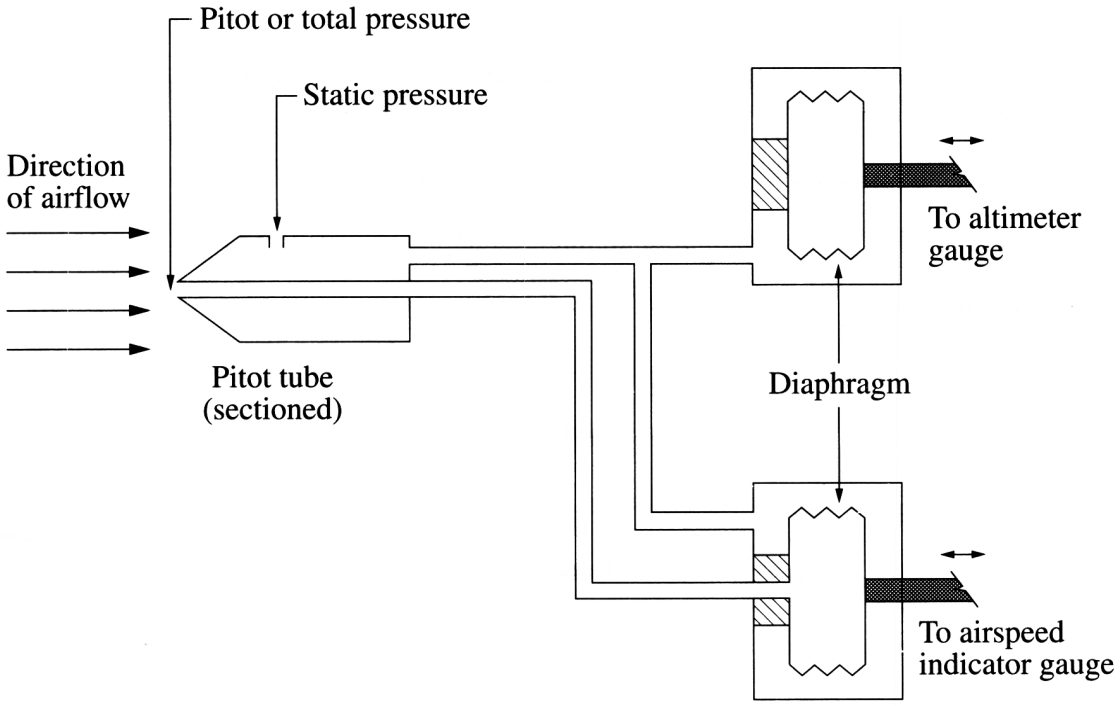
Engineering Studies

Section II (continued)

Marks

Question 15 — Aeronautical Engineering (15 marks)

In common aircraft instruments a pitot tube is connected to both the altimeter and airspeed indicator.



(a) Explain how the airspeed indicator determines airspeed from the pressures sensed by the pitot tube. **3**

The ASI compares the static pressure to the dynamic pressure as sensed by the pitot tube. This gives an indication of the speed of the aircraft through the air as at higher altitudes where the pressure is less a traditional airspeed sensor would be incorrect. Static and dynamic pressure must be measured for an accurate reading.

Question 15 continues on page 22

Marks

Question 15 (continued)

(b) (i) Aluminium and its alloys are generally more active than irons and steels in the galvanic series. Explain why aluminium alloys are more corrosion-resistant than steels. **2**

Although aluminium is more active, and hence corrodes quicker than steel, when it corrodes it forms a thin protective coating that prevents any further corrosion. When steel corrodes it is porous and does not stop further corrosion.

(ii) Identify ONE advantage and ONE disadvantage of the use of composite materials to replace aluminium alloys in aircraft components. **2**

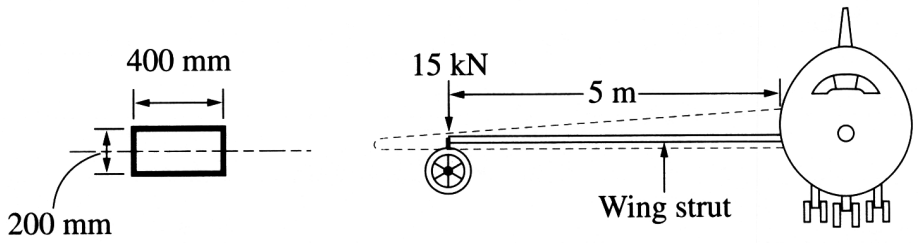
One advantage that composite materials bring are weight reduction which makes the aircraft more efficient. One disadvantage is their unreliability of failure. Many composite materials fail to show signs of stress and will fail suddenly and catastrophically.

Question 15 continues on page 23

Marks

Question 15 (continued)

(c) In the diagram of an aircraft, the wing has been shown as hidden outline to reveal the wing strut, which has uniform section along its length.



Detail of cross-section of wing strut

(i) Compare the nature of the stresses experienced by the surfaces of the wing strut when the aircraft is stationary on the ground and when the aircraft is in flight. **3**

when grounded the strut will experience a negative bending moment. This imposes a tension in the top surface, an compression in the lower surface. There is no force acting longitudinally against the strut (direction of nose to tail). During flight much of the bending moment is relived due to lift, however a bending moment is applied opposite the direction of the flight causing the front surface to be in tension, rear surface in compression.

(ii) Determine the maximum value of the bending stress when the strut experiences a force of 15 kN at its end. **3**

Use $I = 267 \times 10^6\ \text{mm}^4$.

$M = 15 \times 5$
$= 75 \times 10^3\ N$

$y = 100mm$
$= 100 \times 10^{-3}\ m$

$I = 267 \times 10^{-6}$

$\sigma = \frac{My}{I}$

$= \frac{75 \times 100}{267 \times 10^{-6}}$

$= 28.09 \times 10^{-6}$

Bending stress = 28.09×10^{-6} Pa

Question 15 continues on page 24

Marks

Question 15 (continued)

(d) Outline TWO conditions that may cause an aircraft to stall during flight. **2**

Stalling may occur when the angle of attack is to great as a large amount of turbulence will be created on the upper surface of the wing and very little lift.
Stalling can also occur when there is not enough airspeed to overcome the weight of the aircraft.

End of Question 15