9 Passenger loading of a European Airbus Aeroplane

Fig. 9.1 shows data concerning a European Airbus aeroplane to answer the following questions.

Mass of aeroplane, including crew and all equipment	42 000 kg
Maximum number of passengers	150
Average mass of a passenger and baggage	100 kg
Capacity of fuel tanks	18 000 kg
Average fuel consumption	5.0 kg km^{-1}
Safety reserve of fuel at end of journey	3 000 kg
Take-off speed	75 m s^{-1}
Length of runway used	1 500 m

Fig. 9.1

Average fuel consumption is a measure of how much the plane uses to travel a certain distance. This is typically expressed as mass of fuel per unit distance travelled. The capacity of fuel carried at the start of a plane journey includes the safety reserve fuel. The safety reserve fuel is the extra fuel carried beyond what is needed for the planned flight. It should not be used unless during unexpected situations such as delays, diversions or changes in flight conditions.

(a) For a plane carrying maximum capacity of fuel, calculate the maximum safe distance travelled of the aeroplane.

distance travelled = …….. km [1]

(b) Calculate how much further could the aeroplane travel, if at the end of its scheduled flight in **(a)**, the airport it intended to land at was closed due to poor weather conditions.

distance travelled = …….. km [1]

(c) Determine the maximum total mass of the aeroplane, passengers and fuel at the start of a flight.

total mass = …….. kg [1]

(d) Fig. 9.2 shows the variation with time of the lift force on the aeroplane during taking off.

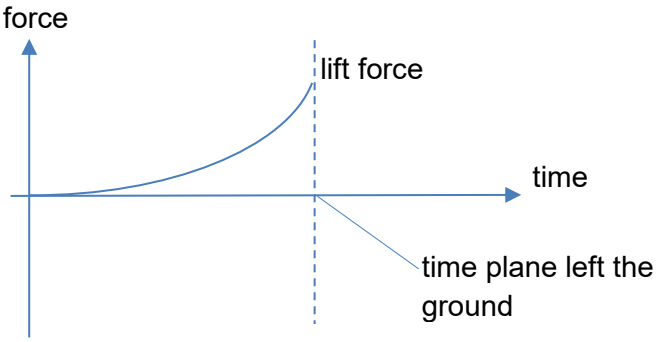

Fig. 9.2

On Fig. 9.2 sketch the variation with time,

(i) the weight of the plane, label the graph **W**, and [1]

(ii) the normal contact force by the ground on the plane, label the graph **N**. [1]

(e) Determine the horizontal acceleration of the aeroplane while it is on the runway when it is taking off.

Assume that the acceleration of the aeroplane is constant.

acceleration = …….. m s^{-2} [2]

(f) Hence determine the force required to cause the acceleration.

force = …….. N [1]

(g) Sometimes aeroplanes find it necessary to take off from shorter than normal runways.

They then have to reduce the number of passengers they carry or the amount of fuel carried. But they are not allowed to reduce their safety margin of reserve fuel.

(i) Assume that your answer in **(f)** remains constant, show that the total mass that can be accelerated to the take-off speed in a distance of 1200 m is 60 000 kg.

mass = …….. kg [1]

(ii) Complete Fig. 9.3 showing the maximum safe distance the aeroplane can travel when carrying different number of passengers.

Length of take-off / m	1500	1200	1200	1200
Number of passengers	150	130	110	90
Mass of aeroplane / kg	42 000			
Mass of passengers / kg	15 000	13 000	11 000	9 000
Total mass of fuel /kg	18 000			
Total mass / kg		60 000	60 000	60 000
Mass of fuel in reserve / kg	3 000			
Usable mass of fuel / kg	15 000			
Maximum safe distance / km				

Fig. 9.3 Data for Airbus with different operating conditions

[2]

(h) For most commercial aeroplane, the *maximum landing weight* is lower than the *maximum take-off weight*.

Hence if an aeroplane needs to return for an emergency landing shortly after take-off, it may need to dump fuel before landing.

Suggest a reason why the maximum landing weight of an aircraft is lower than its maximum take-off weight.

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