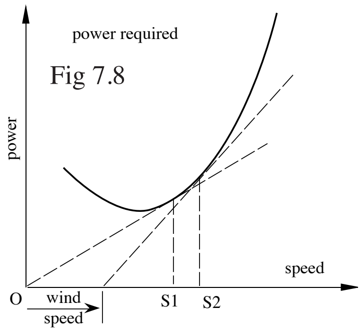
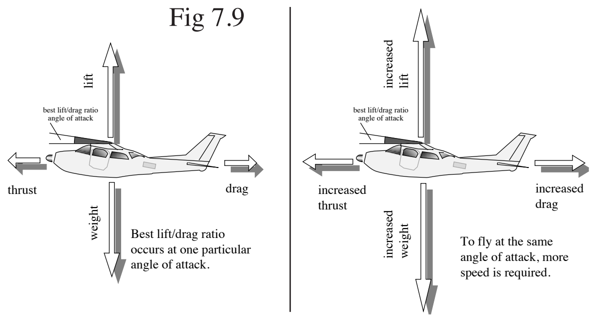


If you're interested, the exact speed required to make the best of the headwind situation is shown in Fig 7.8. The tangent from the origin, O, to the power required curve locates the minimum drag speed [S1].

This is the speed to use for maximum range in no wind. If we move up the speed axis a distance equal to the wind speed and draw a new tangent, we have located S2, the best range speed for that wind condition. By a similar argument, the best speed for range in a tailwind is less than the minimum drag speed.

In practice for light aircraft in normal wind conditions, the actual increase or decrease in speed required to compensate for headwind or tailwind effects is so small it can be safely ignored if normal fuel reserves are carried. In any case, the power required curve for most light aircraft is not included in the available performance data. The examiner will expect you to know that a speed other than the minimum drag speed is required in strong wind conditions, but you will not be required to calculate any actual figures.

Effect of weight. Provided the pilot flies at the correct *angle of attack*, the best lift/drag ratio remains the same and weight has no effect on it [see LIFT/*DRAG RATIO- AEROFOILS* on page 3.6]. However a heavy aircraft requires more lift, so the speed required to achieve the best lift/drag ratio becomes higher. Because lift is greater, drag is also greater, so thrust required increases. To provide more thrust at a higher speed, more power is required. The increase in fuel flow is greater than the increase in speed so range is reduced [Fig 7.9].



Effect of height. In light piston engine aeroplanes without oxygen, height will have very little effect on the range possible if all other factors remain constant. It is much more likely in practice that the availability of favourable winds will decide the height to fly.

However, *in theory* the aeroplane should be operated at a height where *full throttle* can be used to produce the required speed. This would allow the engine to operate at its theoretical best volumetric efficiency. This height is called 'full throttle height' and it is most unlikely that this will ever be a consideration in practice.

For example the best lift/drag ratio speed for a typical light aircraft is simply the speed you would glide at to achieve best gliding range - somewhere around 65 to 70 knots IAS. Imagine climbing to a height where full throttle produced a cruising speed of 65 knots in a Cessna 172! The fuel used to get there, [it would probably be about 17000 to 18000 feet], would be much better spent in getting on with the flight at a lower level - to say nothing about the probability of very strong winds at such a height.

Effect of turbocharging. Because of the rapid reduction of air density with height, any given IAS will occur at a higher TAS as altitude increases. This is because the drag at any TAS reduces in the thinner air. Because the best lift/drag ratio occurs at a particular IAS, it would appear that flying higher would result in a higher TAS when flying at the best lift/drag ratio - but there's a catch! The engine also suffers a reduction in efficiency in the thinner air and eventually there is insufficient power to fly at the higher TAS required. This problem can be overcome by forcing air into the engine with a special type of pump called a *turbocharger*, also called *supercharger* - in fact the Americans call it a *turbosupercharger.*

The extra power available with a turbocharger, allows the best lift/drag ratio IAS to be maintained by flying at a higher TAS in the thinner air at high altitude. With a turbocharged engine, the maximum range possible will be increased by flying at full throttle height at the IAS for best lift/drag ratio.In the case of a turbocharged engine, the full throttle height would be much higher than that of a non-turbocharged [normally aspirated] engine.

All of the items we have considered here relate to achieving *maximum* range. In practice this will rarely be required and many operators have a compromise power setting often referred to as 'long range cruise' which provides good fuel economy but still allows reasonably high cruising speeds. You will hear more about this topic in Aircraft Operation, Performance and Planning and General Knowledge.

