GCSE PHYSICS

COMPONENT 2

Applications in Physics

HIGHER TIER

SAMPLE ASSESSMENT MATERIALS

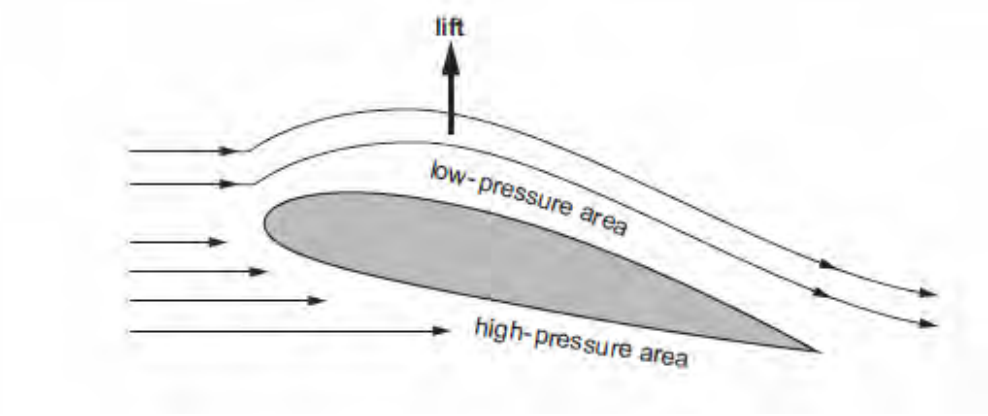
RESOURCE BOOKLET
for use in Section A

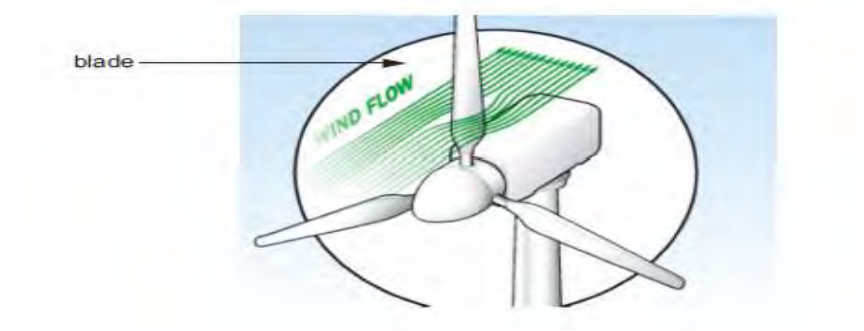
EXPLORING WIND ENERGY

The blades of a wind turbine capture energy from the wind. One surface of the blade is rounded, while the other is flat.

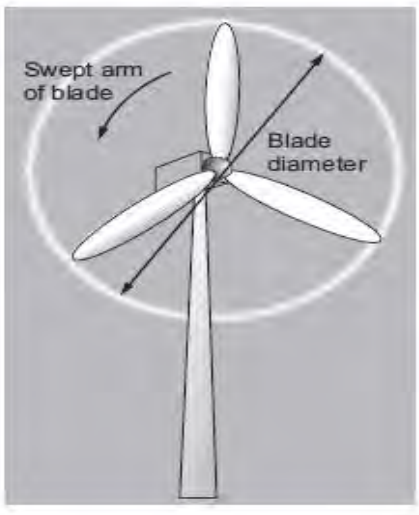
When wind travels over the rounded face of the blade it is forced to move faster than the wind travelling over the flat face of the blade.

The curved surface ends up with a low pressure pocket just above it. On the flat side of the blade, the wind is moving slower and creating an area of higher pressure.





When it comes to deciding where to place wind turbines, knowing how windy the location is, what the wind speeds are and how long those wind speeds last are the key factors. The size of the blades is also important.



The swept area of the blades is given by:

$$\text{swept area} = \pi \times \text{blade radius}^2$$

where $\pi = 3.142$

The kinetic energy (KE) of wind delivered to a wind turbine every second is given by:

$$\text{mean kinetic energy /second} = ½ \times \text{air density} \times \text{swept area} \times (\text{wind speed})^3$$

However, the maximum energy/second that is captured by the turbine from the wind is limited.

Table 1 shows how the **mean** wind speed and density of air vary with altitude at 20 °C.

Table 1

Altitude (m)	Annual mean wind speed (m/s)	Density of air (kg/m^3)
12	7.8	1.192
60	9.5	1.187
100	10.3	1.182
160	10.9	1.173
200	11.3	1.167

Table 2 shows how the density of air varies with temperature at sea level.

Table 2

Temperature (°C)	Density of air (kg/m^3)
+20	1.20
+10	1.25
+5	1.27
0	1.29
-5	1.32

The wind energy industry has been set very ambitious targets for the future. The industry hopes that wind energy can produce 20% of the total EU electricity demand by 2020 and 33% by 2030.