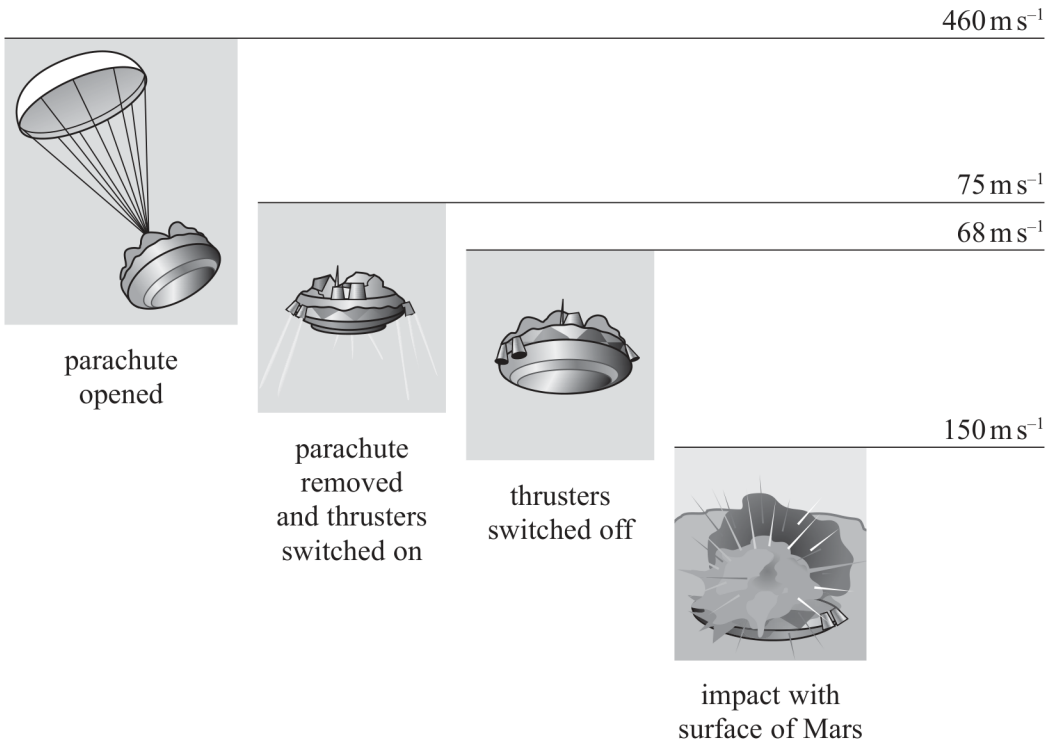
**16** In 2016, the European Space Agency sent the Schiaparelli probe to Mars.

As the probe approached the surface of Mars, with a vertical velocity component of $460\,m\,s^{-1}$, a parachute was opened to reduce the speed of the probe. Once the vertical velocity of the probe had reduced to $75\,m\,s^{-1}$, the parachute was removed and the thrusters were switched on.

Due to an error the thrusters were switched off too soon, leaving the probe to 'free fall' to the surface of Mars.




(a) The parachute was used over a decrease in height of 9.7 km.

(i) Show that the average vertical deceleration of the probe due to the parachute was about $11\,m\,s^{-2}$.

**(2)**

(ii) The parachute was at an angle to the vertical as shown.


Not to scale

The total resistive force acting on the parachute and probe was at an average angle of 6° to the vertical.

Calculate the magnitude of the average total resistive force. You may neglect the mass of the parachute.

mass of probe = 600 kg
gravitational field strength on Mars = 3.8 N kg$^{-1}$

**(3)**

Average total resistive force = .....

(b) The probe was in 'free fall' from a height of 3.7 km, reaching the surface of Mars with a velocity of 150 m s$^{-1}$.

Explain whether the term 'free fall' is correct in this context.
Your answer should include a calculation.

gravitational field strength on Mars = 3.8 N kg$^{-1}$

**(6)**

**(Total for Question 16 = 11 marks)**