1 A raindrop falls vertically from rest. The variation with time t of the vertical velocity of the raindrop is shown in Fig. 1.1.

Fig. 1.1

(a) Use Fig. 1.1 to explain how it may be deduced that air resistance varies with speed.

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....

....

....[2]

(b) A student suggests that the drag force D on the raindrop of mass m falling with a speed v is given by the expression

$$D = k\,v^2$$

where k is a constant.

At speed v, the acceleration of the raindrop is a.

(i) Show that, based on the student's suggestion, and without using data from the graph in Fig. 1.1,

$$(g - a) = \frac{kv^2}{m}$$

where g is the acceleration of free fall.

[2]

(ii) Use information from Fig. 1.1 or otherwise, complete Table 1.2. Show your working clearly.

Table 1.2

velocity v / m s^{-1}	acceleration a / m s^{-2}	$(g - a)$ / m s^{-2}
4.0		
8.0	0	9.8

[2]

(iii) Use the completed Table 1.2 to deduce whether the student's suggestion for velocities of 4.0 m s⁻¹ and 8.0 m s⁻¹ is correct.

[2]

[Total: 8]