2 **(a)** A sphere of radius R is moving through a fluid with constant speed v. There is a frictional force F acting on the sphere, which is given by the expression

$$F = 6\pi DRv$$

where D depends on the fluid.

(i) Show that the SI base units of the quantity D are $\text{kg m}^{-1}\text{ s}^{-1}$.

[3]

(ii) A raindrop of radius 1.5 mm falls vertically in air at a velocity of 3.7 m s^{-1}. The value of D for air is $6.6 \times 10^{-4}\text{ kg m}^{-1}\text{ s}^{-1}$. The density of water is 1000 kg m^{-3}.

Calculate

1. the magnitude of the frictional force F,

$F =$ ..... N [1]

2. the acceleration of the raindrop.

acceleration = ... m s^{-2} [3]

(b) The variation with time t of the speed v of the raindrop in **(a)** is shown in Fig. 2.1.

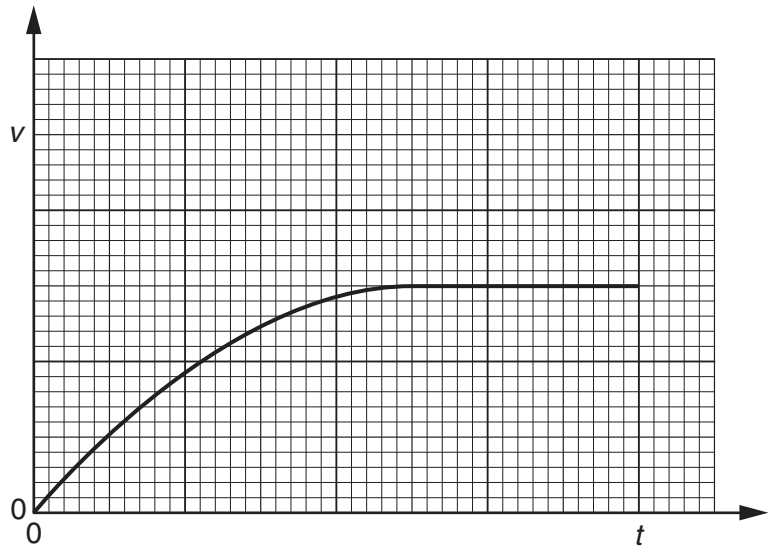

Fig. 2.1

(i) State the variation with time of the **acceleration** of the raindrop.

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..... [3]

(ii) A second raindrop has a radius that is smaller than that given in **(a)**. On Fig. 2.1, sketch the variation of speed with time for this second raindrop. [2]