**13** Raindrops of different sizes fall with different terminal velocities through air.

The table shows the measured value of the terminal velocity for raindrops of different sizes.

| Raindrop size | Drop diameter / mm | Terminal velocity / m $s^{-1}$ |
|---|---|---|
| small | 0.5 | 2.1 |
| medium | 2.0 | 6.5 |
| large | 5.0 | 9.1 |

(a) Derive, using Stokes' law, the following expression for the terminal velocity $v$ of a spherical raindrop in terms of its radius $r$.

$$v = \frac{2g\rho r^2}{9\eta}$$

where $\rho$ is the density of rainwater and $\eta$ is the viscosity of air.

You should ignore upthrust.

**(2)**

(b) Show that the expression given in (a) produces a value of about 800 m $s^{-1}$ for the terminal velocity of a large raindrop.

**(2)**

$\rho = 1.0 \times 10^3$ kg $m^{-3}$
$\eta = 1.8 \times 10^{-5}$ Pa s

(c) Explain whether Stokes' law is suitable for calculating the terminal velocity of raindrops.

**(3)**

**(Total for Question 13 = 7 marks)**