**18*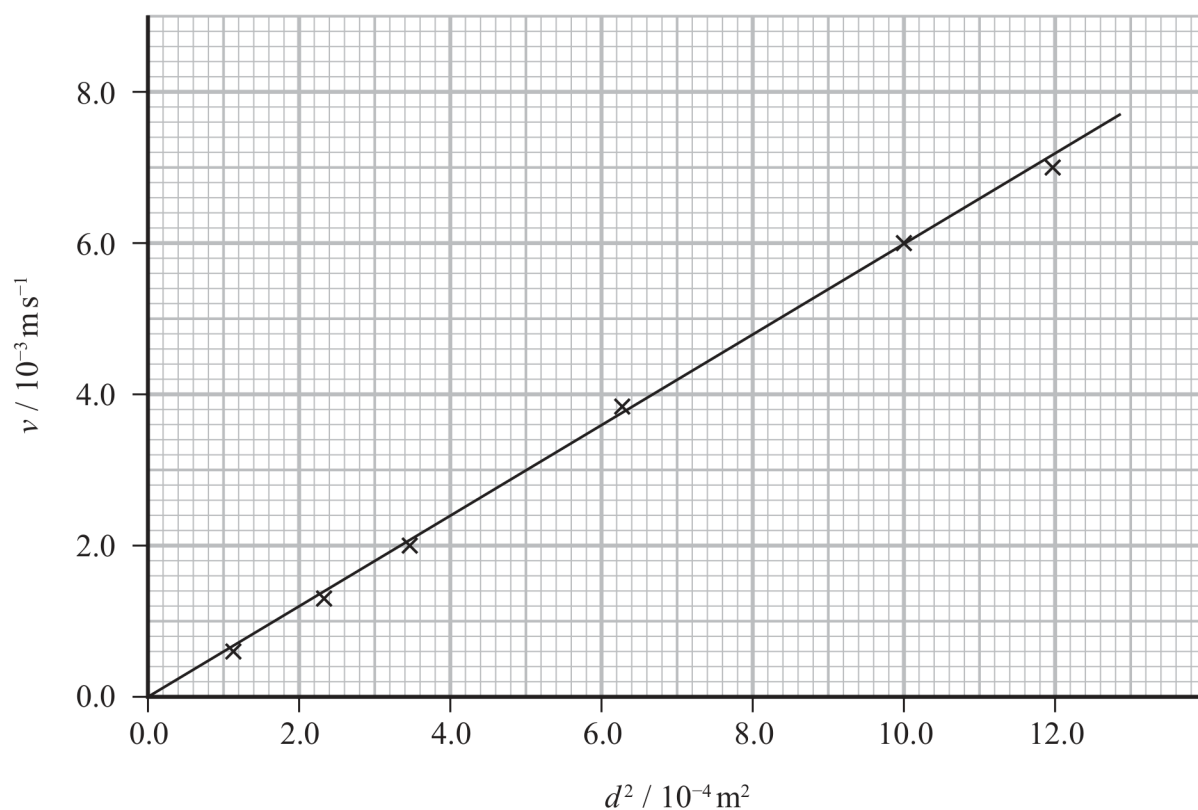* A student carried out an experiment to determine the viscosity of a liquid. He measured the terminal velocities v of several different glass spheres of diameter d, as they fell through the liquid.

The student used his measurements to plot the graph of v against d^2 shown below.

(a) Explain what is meant by terminal velocity.

(2)

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(b) A glass sphere of diameter 35 mm is travelling through the fluid at terminal velocity.

Show that the drag force on this sphere is about 0.2 N.

density of glass $\rho_g = 2.52 \times 10^3 \, \text{kg m}^{-3}$
density of liquid $\rho_s = 1.43 \times 10^3 \, \text{kg m}^{-3}$

(5)

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(c) The student reads in a textbook that if Stokes' law is obeyed

$$v = k d^2$$

where k is a constant.

(i) Deduce from the graph whether the flow of liquid around the spheres was laminar.

(3)

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(ii) Determine a value for k using the student's graph.

(3)

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$k = $ ....

(iii) The constant k is given by

$$k = \frac{\left(\rho_g - \rho_s\right)g}{18\eta}$$

where η is the viscosity of the liquid.

Determine a value for η.

density of glass $\rho_g = 2.52 \times 10^3 \, kg \, m^{-3}$
density of liquid $\rho_s = 1.43 \times 10^3 \, kg \, m^{-3}$

(2)

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$\eta = $ ....

(Total for Question 18 = 15 marks)