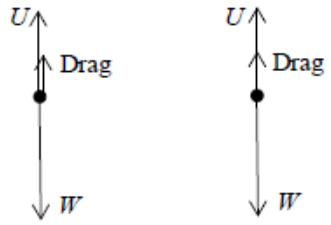
Fluids - Mark Scheme

Q1.

Question Number	Answer		Mark
(a)(i)	Place two or more rubber bands or markers (on the cylinder) (accept markers correctly placed and labelled on diagram)	(1)	
	The top band should be far enough below the surface for terminal velocity to have been reached **Or** have more than 2 markers and check velocity is constant.	(1)	
	Measure time for the sphere to fall a given distance (using the stopwatch) **and** measure distance fallen (using the metre rule)	(1)	
	Either Reference to repeated measurements and averaging	(1)	
	(terminal velocity =) $\frac{\text{distance between markers}}{\text{(average) time between markers}}$	(1)	
	Or measure the times for different distances	(1)	
	(terminal velocity =) gradient of graph of distance against time	(1)	**(5)**
(a)(ii)	A larger sphere would have a greater (terminal) velocity	(1)	
	Weight is greater **Or** terminal velocity is proportional to r^2 **Or** takes more time to reach terminal velocity	(1)	
	The time of falling would be less	(1)	
	The (absolute) uncertainty in the time is the same **Or** Resolution of the stopwatch is the same **Or** Reaction time is the same (or they are a greater proportion of the (measured) time)	(1)	**(4)**

(b) (i)	Upthrust/U up	(1)	
	Drag/friction/D up	(1)	
	Weight/W/mg down	(1)	**(3)**
	(−1 for each extra force over 3) (−1 if any arrow does not touch the dot) (−1 if any arrow is not close to vertical) (Accept single line up with two labelled arrow heads. Ignore the length of the arrows.)		
	Examples:  		
(b) (ii)	Weight = (upthrust +) drag with indication that W=3.5×10^{-2} N	(1)	
	Use of upthrust = $\rho_l Vg$	(1)	
	Use of drag = $6\pi r\eta v$	(1)	
	η = 2.1 (Pa s)	(1)	**(4)**
	<u>Example of calculation</u> $V = \frac{4}{3}\pi(4.8 \times 10^{-3}\ \text{m})^3 = 4.63 \times 10^{-7}\ \text{m}^3$ Upthrust = $1.1 \times 10^3\ \text{kg m}^{-3} \times 4.63 \times 10^{-7}\ \text{m}^3 \times 9.81\ \text{N kg}^{-1} = 5.00 \times 10^{-3}$ N $3.5 \times 10^{-2}\ \text{N} = 5.0 \times 10^{-3}\ \text{N} + 6\pi(4.8 \times 10^{-3}\ \text{m} \times \eta \times 0.160\ \text{m s}^{-1})$ η = 2.07 Pa s		
	Total for question		**16**

Q2.

Question Number	Answer	Mark
	The only correct answer is D **A** *is not the correct answer as smaller particles of sand have a lower terminal velocity so take longer to reach the bottom of the beaker* **B** *is not the correct answer as a lower temperature would increase the viscosity and increase the time taken for the particles to reach the bottom of the beaker (lower terminal velocity)* **C** *is not the correct answer as the sand particles take longer to reach the bottom of the beaker with a smaller terminal velocity*	(1)

Q3.

Question Number	Answer	Mark
(a)	• Laminar/non-turbulent flow **Or** Slow moving sphere (1)	**(1)**
(b)	• Use of $W = mg$ (1) • $W = U + D$ (1) • Use of $F = 6\pi\eta v$ (1) • Use of $W = U + D$ to obtain quantity to compare, *e.g.* $D = (-)\ 7.8 \times 10^{-3}$ (N) (1) • Comparison leading to valid conclusion from candidate's calculation. e.g. $F = 2.5 \times 10^{-5}$ N $\neq D$ **or** v = 155 m s^{-1} $\neq$ 0.5 m s^{-1} *et al.* (1) Example of calculation $W = 9.1 \times 10^{-4}$ kg $\times$ 9.81 N kg^{-1} = 9.0×10^{-3} N $\Sigma F = 9.0 \times 10^{-3}$ N $- 1.1 \times 10^{-3}$ N $-$ drag = 0 Drag = (–) 7.9×10^{-3} N $F = 6 \times \pi \times 3.0 \times 10^{-3}$ m $\times$ 8.9×10^{-4} Pa s $\times$ 0.50 m s^{-1} $F = 2.5 \times 10^{-5}$ N	**(5)**

Q4.

Question Number	Answer	Mark
	D is the correct answer A is not the correct answer as Stokes' Law does not apply to large spheres moving quickly through a fluid B is not the correct answer as Stokes' Law does not apply to large spheres C is not the correct answer as Stokes' Law does not apply to spheres moving quickly through a fluid	**(1)**