Question Number	Answer		Mark
3(a)	• Diameter value = 17.90 mm • Use of half resolution (0.005 mm) • Percentage uncertainty = 0.03 (%) <u>Example of calculation</u> Percentage uncertainty = (0.005 mm / 17.90 mm) × 100 % = 0.028 %	(1) (1) (1)	**3**
3(b)	• Check for zero error Allow do not overtighten	(1)	**1**
3(c)(i)	• When stationary, the reading on the force meter = weight (− upthrust) • When moving (at a constant speed), the reading on the force meter = weight + drag (− upthrust) • Subtracting the two readings gives the value of drag For MP1 and MP2 – accept descriptions given as an equation e.g. When stationary $F_1 = W - U$ When moving $F_2 = W + D - U$	(1) (1) (1)	**3**
3(c)(ii)	• Subtracts the two forces (F = 0.09 N) • Use of $F = 6\pi\eta rv$ • η = 1.7 (Pa s) <u>Example of calculation</u> F = 0.29 N – 0.20 N F = 0.09 N $F = 6\pi\eta rv$ $\eta = F/6\pi rv$ η = 0.09 N / (6 × π × 0.00895 m × 0.32 m s^{-1}) η = 1.67 Pa s	(1) (1) (1)	**3**
3(d)	• A comment assessing uncertainty in force • A comment assessing uncertainty in distance • A comment assessing uncertainty in time • Conclusion justified by their assessments MP4 requires some numerical comparison <u>Examples of assessments for MP1-3</u> *Force* • Resolution of the force meter is 0.01 N, so percentage uncertainty is 11% (accept 5.5% or 6%) • Force difficult to keep constant, variation likely to be larger than 0.01 N *Distance* • Meter rule resolution of 1mm, so percentage uncertainty is small • Percentage uncertainty in distance measurement is 0.2% *Time* • Resolution of the stopwatch is 0.01 s, so percentage uncertainty is 0.6 % • Time is short, so reaction time (0.2 s) will be a significant percentage (25%) or fraction (1/4) of the time measured • Not enough time to move eyeline, so there may be parallax error when judging when the sphere has passed the rubber band.	(1) (1) (1) (1)	**4**
	Total for question 3		**14**