

1	The only correct answer is D (W) A is not correct because upthrust is equal to the weight of liquid displaced B is not correct because upthrust is equal to the weight of liquid displaced C is not correct because upthrust is equal to the weight of liquid displaced	1
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3	The only correct answer is B because Upthrust is equal to weight of sphere (2.5 N). Weight of displaced water if half sphere submerged = 2.5 N Weight of displaced water if all of sphere submerged = 5.0 N Total upwards force acting on sphere when completely submerged = 5.0 N Total downwards force on sphere if completely submerged (and stationary) = 5.0 N <i>F</i> must be equal to 2.5 N <i>A is not the correct answer as $F = 2.5\text{ N}$</i> <i>C is not the correct answer as $F = 2.5\text{ N}$</i> <i>D is not the correct answer as $F = 2.5\text{ N}$</i>	(1)
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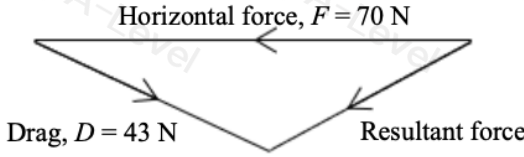
7	B decreased by $(2.4 \times 10^{-5}) \times (1000) \times (9.81)$ Incorrect Answers: A – this is just the mass of the displaced water C – the reading will decrease and not increase due to the upthrust acting upwards on the object by the weight, and not the mass, of the displaced water (upthrust) D – the reading will decrease and not increase due to the upthrust acting upwards on the object	1
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Question Number	Answer	Mark
13(a)	Distance $P = D - h$ (1) Distance $Q = D$ (1)	2
*13(b)	(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate) Max 5 A statement or description of tension = weight – upthrust (+ drag) (1) (Initially) tension constant as upthrust is constant Or (Initially) the graph is flat as upthrust is constant in water (1) The speed is slow/constant in water so friction is constant/negligible (1) As the cylinder moves through the surface of the water the volume/weight/mass of displaced water decreases (1) The tension increases because the upthrust decreases Or the tension increases as the upthrust is proportional to submerged volume (1) (Once above the water the) tension greater/constant as tension = weight Or (Once above the water the) tension greater/constant as upthrust is negligible/small (1)	5
	Accept symbols for tension, weight and upthrust but symbols must be defined if QWC awarded	
	Total for question 13	7

Question Number	Answer	Mark
19(a)	• Upthrust/U upwards (1) • Tension/T upwards (1) • Weight/W/mg downwards (1) (-1 for each extra force over three, -1 if any arrow does not touch the dot, -1 if any arrow is not close to vertical. Accept a single line up with two labelled arrowheads.)	(3)
19(b)(i)	• Water exerts upward force on sphere. (1) Or Water exerts an upthrust on the sphere. • Sphere exerts a downwards/opposite force on water by Newton's Third Law. (1) • Extra downward force on water (increases reading on balance).	(1) (3)

19(b)(ii)	• Mass of displaced water = 150 g (1) • Use of $V = m/\rho$ for water with $\rho = 1\,000\text{ kg m}^{-3}$ (150 ml) (1) • Use of $m = \rho V$ for sphere WITH $\rho = 2\,000\text{ kg m}^{-3}$ (1) • $m = 0.30\text{ kg}$ (1) <u>Example of calculation</u> Increase in weight of water = force of ball on water = upthrust on ball Mass of displaced water = 465 g – 315 g = 150 g Volume of sphere = $\frac{0.150\text{ kg} \times g}{1000\text{ kg m}^{-3} \times g} = 1.5 \times 10^{-4}\text{ m}^3$ Mass of sphere = $2000\text{ kg m}^{-3} \times 1.5 \times 10^{-4}$ (4)	
19(b)(iii)	• Upthrust less in oil or weight of displaced oil less or downward force of sphere on oil less (1) • (Therefore increase in) balance reading less (than for water). (1) (MP2 dependent on MP1)	(2)
Total for question 19		12

Question Number	Answer	Additional Guidance	Mark
17(a)	Calculates volume of one lifting bag Calculates volume of box Use of $\rho = \frac{m}{V}$ Use of $W = mg$ Total upthrust = 2700 N Comparison of calculated upthrust with 2500 N and consistent conclusion	(1) <u>Example calculation</u> (1) $V_{\text{bag}} = \frac{4}{3} \times \pi \times \left(\frac{0.5\text{ m}}{2}\right)^3 = 0.0654\text{ m}^3$ (1) $V_{\text{box}} = 1.1 \times 0.5 \times 0.25\text{ m} = 0.138\text{ m}^3$ (1) $V_{\text{total}} = 2 \times 0.0654\text{ m}^3 + 0.138\text{ m}^3 = 0.269\text{ m}^3$ (1) $m_{\text{displaced water}} = 1020\text{ kg m}^{-3} \times 0.269\text{ m}^3 = 274\text{ kg}$ (1) $W_{\text{displaced water}} = 274\text{ kg} \times 9.81\text{ N kg}^{-1} = 2690\text{ N}$ 2690 (N) > 2500 N so the box will be lifted	6
17(b)(i)	Calculates resultant of weight and upthrust Use of $F = 6\pi\eta r v$ Terminal velocity = 13.0 m s^{-1}	(1) <u>Example calculation</u> (1) $F = 4.77 \times 10^{-4}\text{ N} - 1.82 \times 10^{-6}\text{ N} = 4.752 \times 10^{-4}\text{ N}$ (1) $v = \frac{4.752 \times 10^{-4}\text{ N}}{6 \times \pi \times 8.60 \times 10^{-4}\text{ Pa s} \times 2.25 \times 10^{-3}\text{ m}} = 13.03\text{ m s}^{-1}$	3

Question Number	Answer	Mark
18(a)	Straight arrow at least 3.5 cm long representing horizontal force, with label F , horizontal force or 70 N	(1)
	Vector triangle drawn with at least two sides in the triangle labelled, and horizontal force on the longest side.	(1)
	All three arrows in correct relative directions (dependent on MP2)	(1)
	Magnitude = 36 N (allow an answer in the range 34 N to 38 N)	(1)
	Angle to horizontal = 30° Or 150° (allow a tolerance of $\pm 2^\circ$)	(1)
	<u>Example diagram</u> 	5